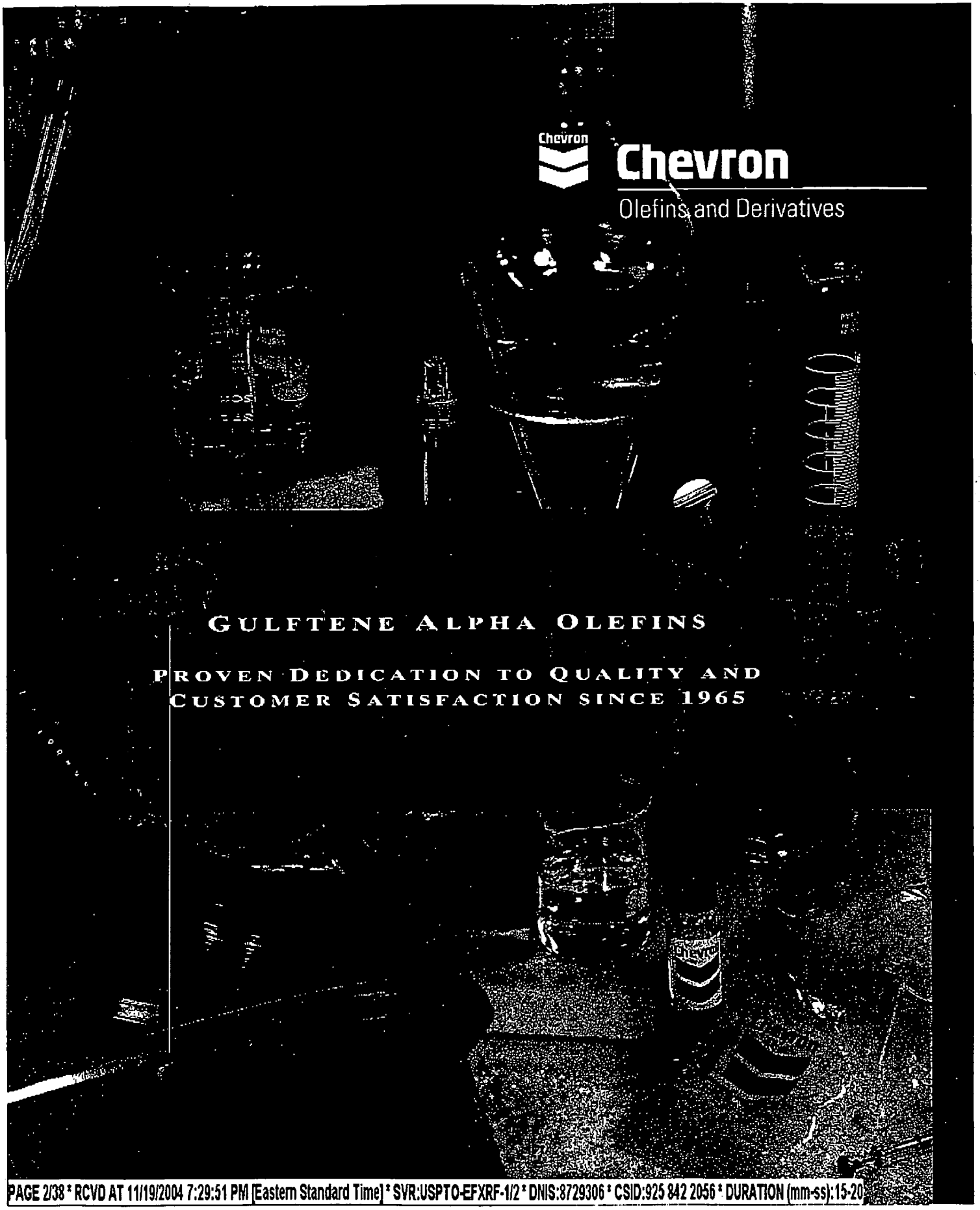

Chevron
Chevron
Olefins and Derivatives
GULFTENE ALPHA OLEFINS
PROVEN DEDICATION TO QUALITY AND
CUSTOMER SATISFACTION SINCE 1965

More than 700 million pounds or 320,000 metric tonnes of Gulftene alpha olefins are produced annually at Chevron's state-of-the-art Cedar Bayou Petrochemical Complex.

THE CHEVRON DISTINCTION

Pioneered for commercial use in 1965 by Gulf Oil Chemicals Company, Gulftene® alpha olefins are produced and marketed worldwide by the Olefins and Derivatives Division of Chevron Chemical Company. Since acquiring this product line, we have unrelentingly pursued our mission to be the most reliable supplier of consistent, high-quality normal alpha olefins for the many customers we serve.

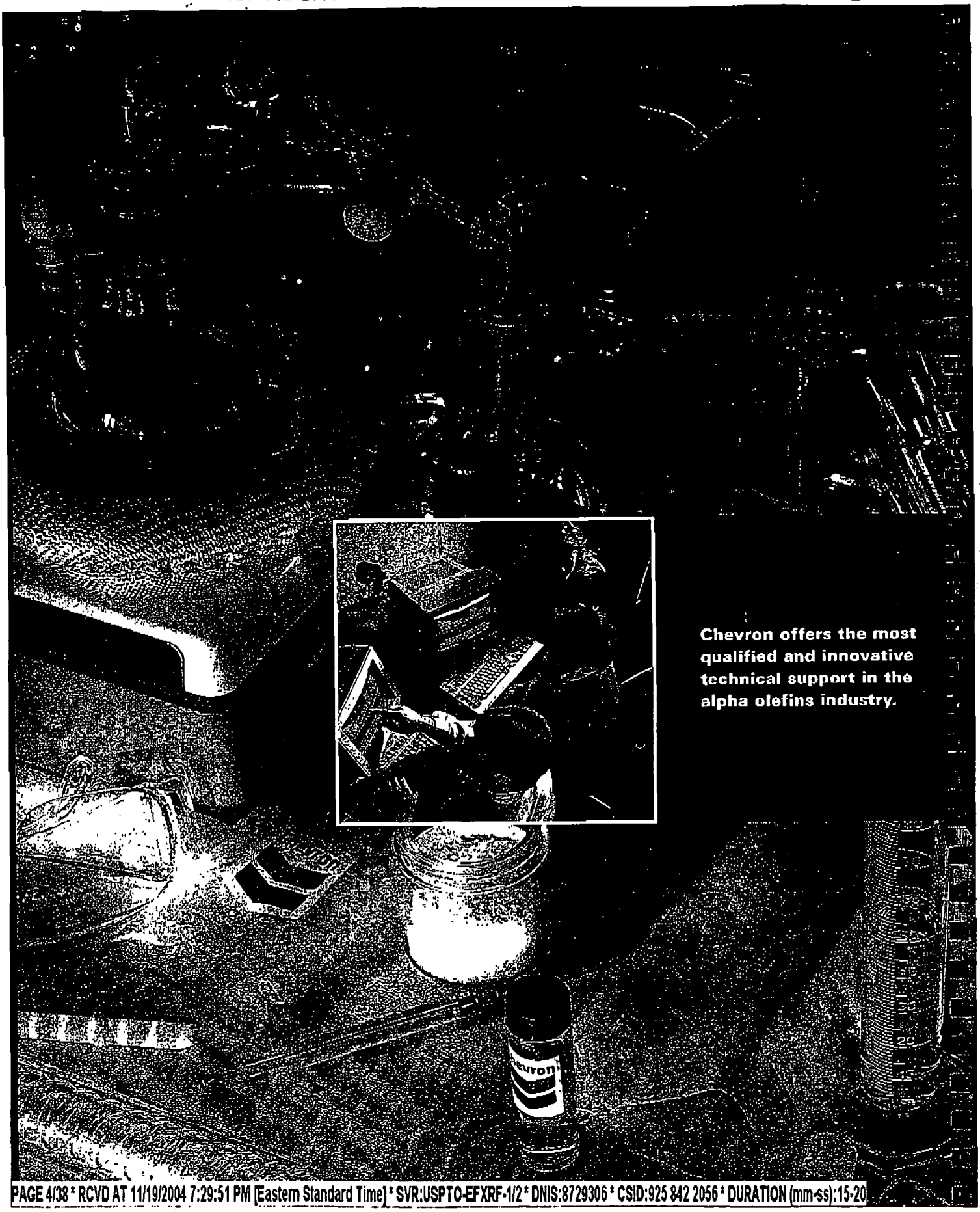
Ongoing Quality Commitment

From technical development and support, manufacturing, sales and marketing, to shipping and customer service, each and every individual at Chevron is committed to premium-quality products, outstanding service and continual improvement of our processes. When you buy Chevron's Gulftene alpha olefins, you buy quality right up to the time they're delivered to your door, whether you are in Antwerp, South Bend, Singapore or Baton Rouge. That's the Chevron distinction.

Quality Products for Every Application

Chevron Chemical offers a complete line of alpha olefins to meet our customers' specific needs. We produce 11 distinct carbon-length fractions, including: C_4 (1-butene), C_6 (1-hexene), C_8 (1-octene), C_{10} (1-decene), C_{12} (1-dodecene), C_{14} (1-tetradecene), C_{16} (1-hexadecene), C_{18} (1-octadecene), C_{20-24}, C_{24-28} and C_{30+}. C_4 through C_{18} are even-numbered carbon cuts, while fractions C_{20-24} and above are olefinic waxes. The alpha olefins C_{18} and below can be custom-blended for special applications.

Gulftene alpha olefins, featuring highly accessible terminal double bonds, are ideal materials for manufacturing numerous products. Alpha olefins or their derivatives are used extensively as polyethylene comonomers, plasticizers, synthetic motor oils, lubricants, automotive additives, surfactants, paper size and in a wide range of specialty applications. As major petrochemical building blocks, their use in the development of new chemical products is virtually unlimited.


Chevron offers the most qualified and innovative technical support in the alpha olefins industry.

Reliable Supply of Alpha Olefins

All Chevron Gulftene alpha olefins are produced at our state-of-the-art Cedar Bayou Petrochemical Complex just outside Baytown, Texas, near Houston. From an original output of 120 million pounds annual production, we added another production facility, expanding to a current capacity of more than 700 million pounds or 320,000 metric tonnes annually. Ongoing facility expansion enables us to ensure a dependable supply of consistent, high-quality alpha olefins now and for the future. This is just one of the many ways Chevron is meeting the growing needs of customers worldwide.

Our normal alpha olefin units are equipped with advanced instrumentation and control equipment to maintain production efficiency and uniform quality. A distributed control system (DCS) in tandem with online analyzers for real-time monitoring greatly enhances our units' abilities to maintain product consistency.

Online process sampling verifies carbon number quality and normal alpha olefin content. Quality control and product analysis are performed in our onsite petrochemical laboratory to ensure the quality of our Gulftene products.

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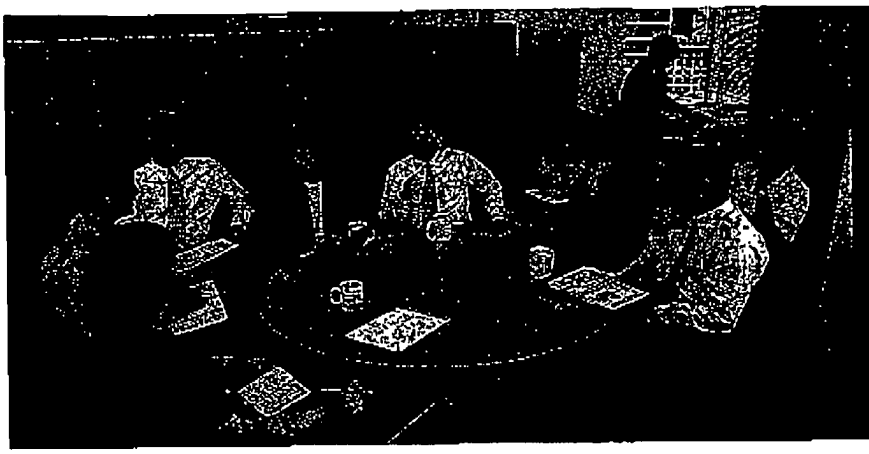
Chevron People Do . . .

When it comes to alpha olefins, Chevron offers a consistently high level of product purity and the widest selection of fractions. However, what really differentiates us is the teamwork, technical expertise, and commitment of every employee to continuous quality improvement and customer service.

Our dedication to supplying consistently high-quality products and services is not something we just talk about. It is a conviction that we practice daily. Our Total Quality Management program is applied to every aspect of our business, as demonstrated in our ISO 9002 certification. Chevron's people have made all this possible.

Highly trained professionals from technical, manufacturing, sales and marketing, customer service and shipping work together to efficiently and innovatively meet the needs of our customers worldwide. We diligently seek out customers' opinions through surveys and direct contact to guide our



Behind Chevron's success as a global supplier of alpha olefins is a team dedicated to serving customers' needs.

Our strategically located offices in Houston, Texas; Voorhees, New Jersey; Geneva, Switzerland; and Singapore are staffed with experienced, technical account managers. These individuals are there to assist you with all your alpha olefins requirements—from the usual to the most challenging requests.

Our respected technical group, based in Kingwood, Texas, works closely with customers to enhance product quality, improve existing olefin and derivative technologies and help develop new applications.

Knowledgeable customer account representatives, supported by a team of distribution account representatives, are available 24 hours a day. They work closely with the other business functions to ensure that our Gulftene products are delivered on time anywhere in the world.

In addition, we use the most advanced business systems available, enabling us to provide the most efficient service possible. Everything from order taking, deliveries and inventory to accounting, forecasting and supplying samples is instantly at our fingertips so we can provide prompt responses to your questions and requests.

TYPICAL PHYSICAL CHARACTERISTICS

Gulftene alpha olefins, from C_4 to C_{30+} carbon lengths, are high-quality intermediates. They are straight-chain hydrocarbons with a double bond in the terminal position. At ambient conditions, C_4 is a gaseous product and C_6 through C_{18} are clear, water-white liquids with a distinctive olefinic odor. The C_{20+} products are solid at room temperature and have a white, waxy appearance.

TYPICAL PROPERTIES (1)	C_4	C_6	C_8	C_{10}	C_{12}	C_{14}	C_{16}	C_{18}	$C_{20/24}$	$C_{24/28}$	C_{30+}
Monoolefin, %	99.7		99.7		99.7		99.7		99.7		99.4
Alpha Olefin, %	99.6		97.4		95.2		92.3				
Saturates, %	0.3		0.3		0.3		0.3		0.3		0.6
Molecular Weight	56.1		112.2		168.3		224.4				
Flash, °C, TCC, ASTM D56			13		77						
Flash, °C, PMCC, ASTM D93							132		183		252
Freezing Point, °C, ASTM D1015					-1		4				
Melting Point, °C, ASTM D87									36		77*
Density at 15.6°C, Lb./Gal.	5.01		5.99		6.35		6.54		6.41(3)		6.58(4)
Specific Gravity at 15.6°C/15.6°C	0.602		0.719		0.763		0.785		0.799		0.836
Destillation, °C, ASTM D86											
10% Distilled			120.1		210.2		279.8				
90% Distilled			122.7		215.4		285.4				

*Drop melting point, ASTM D127

(1) More information on each product may be found in the information sheets at the back of this brochure.

(2) At 25°C

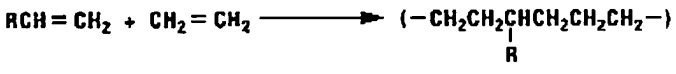
(3) At 71°C

(4) At 85°C

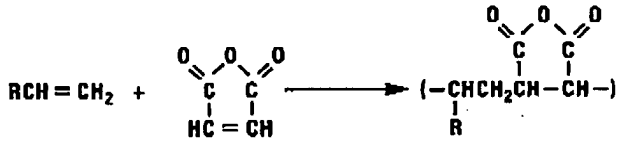
TYPICAL REACTIONS

Polymerization

Ethylene and Gulftene alpha olefins can be copolymerized by conventional catalyst systems used to produce high-density and linear low-density polyethylene. Gulftene products can also be homopolymerized with the same catalysts, producing 1-polybutene, for example.

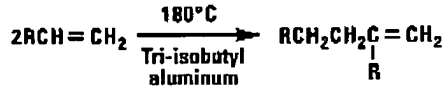


Our alpha olefins can also be copolymerized with maleic anhydride or maleate esters via free radical initiators to produce alternating 1:1 copolymers.



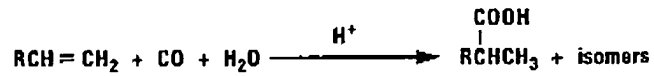
Oligomerization and Dimerization

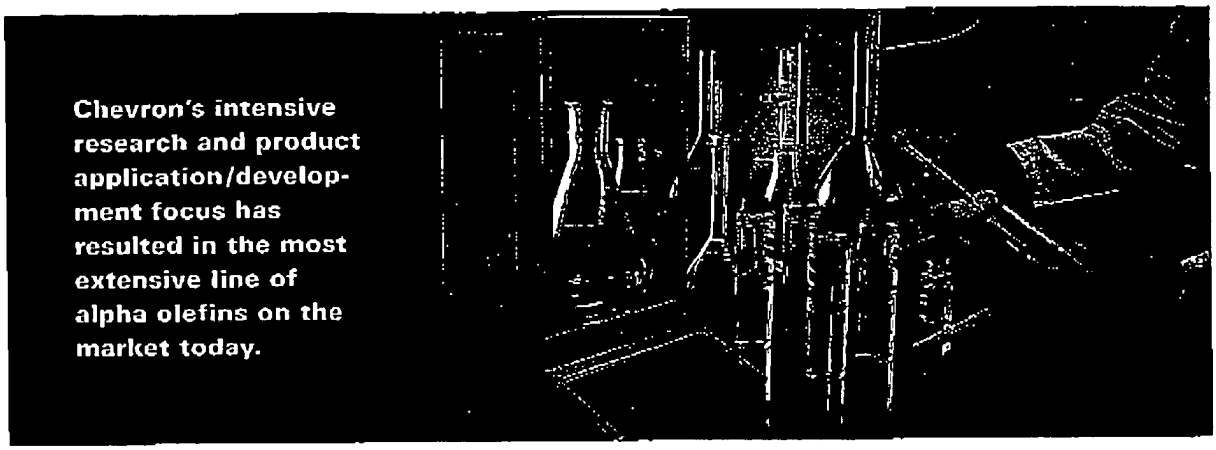
Gulftene alpha olefins can be treated with Lewis acids to produce dimers, trimers, tetramers and related compounds. The resultant products are highly branched and consequently have much lower pour points than straight-chained hydrocarbons of the same molecular weight. Dimers with a terminal double bond and an alkyl group on the second carbon of the double bond can also be produced by using an aluminum alkyl catalyst.



Koch Reaction

The Koch reaction produces a mixture of branched carboxylic acids from alpha olefins. The reaction proceeds in the absence of a solvent and is applicable to C_6 to C_{24} alpha olefins.





$$RCH=CH_2 + CO + H_2 \xrightarrow[300\ psig\ 100°C]{RhHCO[P(Ph)_3]_3} RCH_2CH_2\overset{O}{\overset{\|}{C}}H$$

$$RCH=CH_2 + CO + 2H_2 \xrightarrow[1800\ psig\ 175°C]{Cobalt/PR_3} RCH_2CH_2CH_2OH + R'CH_2\overset{CH_3}{\overset{|}{C}}HCH_2OH$$

$$RCH=CH_2 + CO + CH_3OH \xrightarrow[2000\ psig\ 180°C]{Cobalt/Pyridine} RCH_2CH_2\overset{O}{\overset{\|}{C}}-OCH_3$$

$$RCH=CH_2 + CO + HCl \xrightarrow[1500\ psig\ 100°C]{PdCl_2(PPh_3)_2/SnCl_2} RCH_2CH_2\overset{O}{\overset{\|}{C}}Cl$$

Oxo Chemistry

Chevron alpha olefins will react with carbon monoxide and a variety of nucleophiles to produce aldehydes, alcohols, esters or acid chlorides.

$$RCH=CH_2 + HBr \xrightarrow[Antioxidant]{Dark} RCH\underset{Br}{\underset{|}{C}}H_3$$

$$RCH=CH_2 + HBr \xrightarrow[Peroxides]{UV\ or} RCH_2CH_2Br$$

Addition of Hydrogen Bromide

Secondary or primary alkyl bromides will result from the reaction of hydrogen bromide with our alpha olefins by Markownikoff or anti-Markownikoff addition.

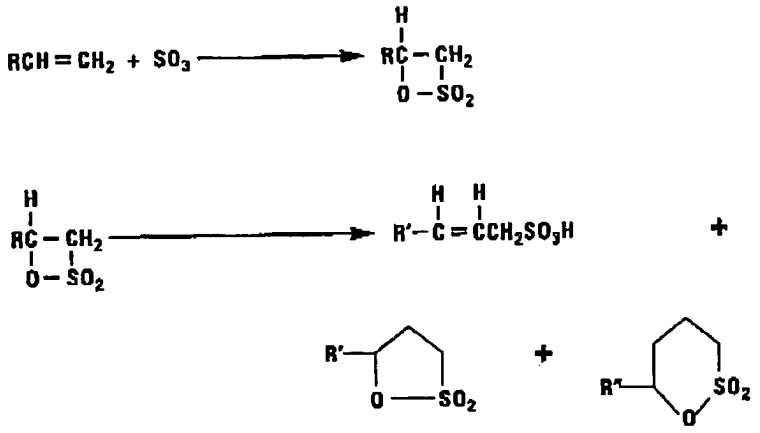
$$RCH=CH_2 + NaHSO_3 \xrightarrow[Initiator]{Free\ Radical} RCH_2CH_2SO_3Na$$

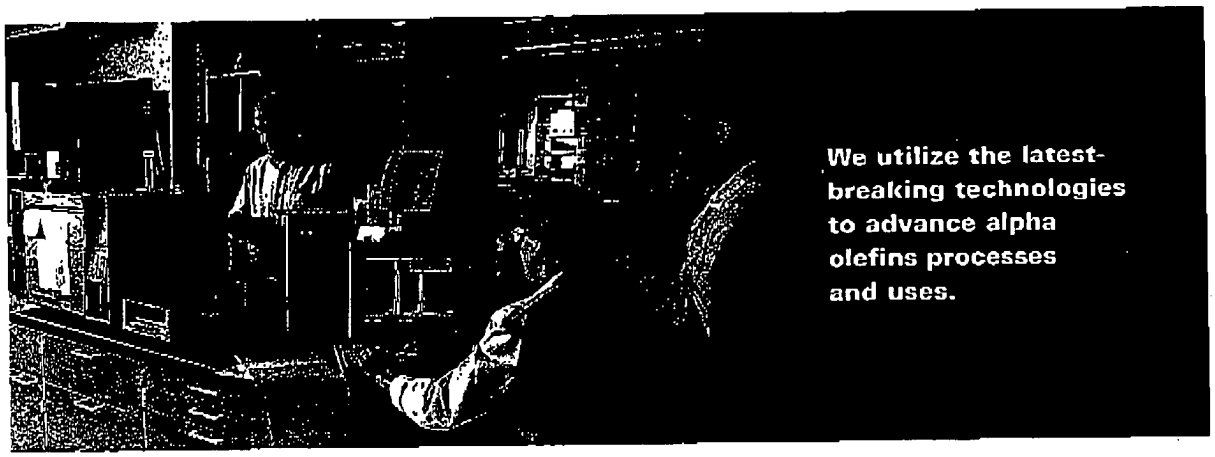
Addition of Sodium Bisulfite

Sodium bisulfite can be directly added to Chevron alpha olefins using peroxides or other free radical initiators, producing a sodium alkane sulfonate with the sulfonate group in the terminal position.

Addition of Sulfur Trioxide

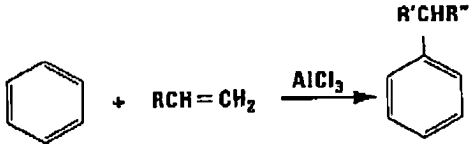
Sulfur trioxide reacts with alpha olefins in a highly exothermic reaction via a 2 + 2 cyclo addition mechanism to produce a beta sultone as the initial product. The sultone is unstable and rearranges into a mixture of alkene sulfonic acids plus gamma and delta sultones.





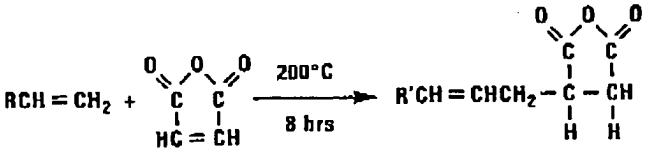
Alkylation Reactions

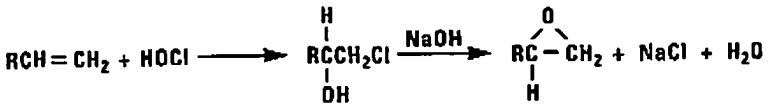
With acid catalysis, alpha olefins readily alkylate aromatic compounds such as benzene and phenol. The products are mixtures of linear alkyl aromatics, ideal for conversion to detergents via sulfonation or ethoxylation.

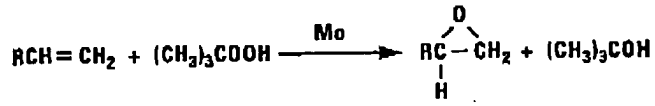


Addition of Maleic Anhydride

Alpha olefins and maleic anhydride react to form alkenyl succinic anhydrides (ASA).

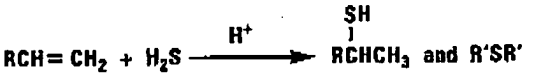






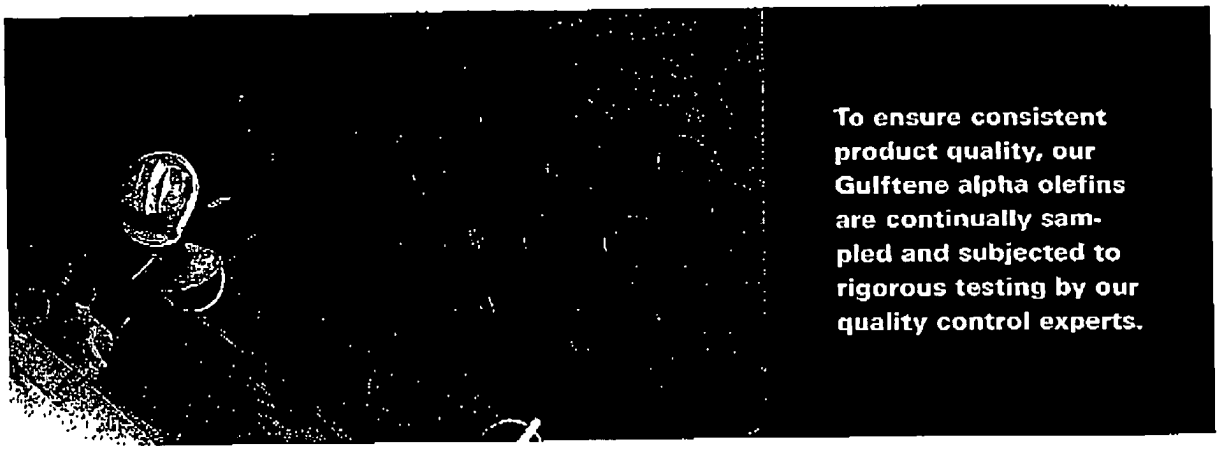
Epoxidation

Alpha olefins can be converted into 1,2 epoxides by the addition of hypochlorous acid followed by treatment with base, treatment with peracids, or by using t-butylhydroperoxide and a molybdenum catalyst.



Addition of Hydrogen Sulfide

When hydrogen sulfide is added to alpha olefins, mercaptans and sulfides are produced. The relative yields of each can be influenced by reaction conditions and reactant concentrations. In the absence of free radicals, Markownikoff addition will occur. However, the presence of peroxides or UV light will induce anti-Markownikoff addition.



Addition of Halogens

Chlorine and bromine both readily add to alpha olefins to form 1,2-dihaloalkanes. Because the reaction is highly exothermic, it should be carried out slowly with cooling.

$$RCH=CH_2 + Cl_2 \longrightarrow RCH(Cl)-CH_2(Cl)$$

$$RCH=CH_2 + Br_2 \longrightarrow RCH(Br)-CH_2(Br)$$

Addition of Hydrogen Chloride

Using a weak Lewis acid catalyst, hydrogen chloride reacts with alpha olefins to form secondary alkyl chlorides. The reaction is a typical Markownikoff addition. Hydrogen chloride and alpha olefins will not react in an anti-Markownikoff manner because the H-Cl bond strength is too great.

$$RCH=CH_2 + HCl \xrightarrow{SnCl_4} RCH(Cl)-CH_2(H)$$

TYPICAL APPLICATIONS

High-quality Gulftene alpha olefins are used in a myriad of commercial products, including polymers, synthetic fluids, surfactants, additives and specialty chemicals.

The terminal double bonds of Gulftene alpha olefins react readily with a wide variety of chemicals (see Typical Reactions, pages 6 through 10). Alpha olefins can be used to synthesize any derivative requiring an even-numbered, straight carbon chain.

TYPICAL APPLICATIONS	C_4	C_6	C_8	C_{10}	C_{12}	C_{14}	C_{16}	C_{18}	$C_{20/24}$	$C_{24/28}$	C_{30+}
Polymers											
Polyethylene Comonomers	■	■	■								
Homopolymers	■										
Copolymers		■	■	■	■	■	■	■	■	■	■
Surfactants											
ADS		■	■	■	■	■	■	■	■	■	■
Detergent Alcohols		■	■	■	■	■	■	■	■	■	■
Alkyl Aromatics		■	■	■	■	■	■	■	■	■	■
ABMA					■	■	■	■	■	■	■
Synthetic Fluids											
Polyalphaolefins		■	■	■	■	■	■	■	■	■	■
Polyol Esters	■	■	■	■	■	■	■	■	■	■	■
Lube Oil Additives											
Additives							■	■	■	■	■
Plasticizer Alcohols	■	■	■	■	■	■	■	■	■	■	■
ASA			■	■	■	■	■	■	■	■	■
PVC Lubricants											■
Specialty Chemicals											
Epoxides	■	■	■	■	■	■	■	■	■	■	■
Mercaptans	■	■	■		■	■	■	■	■	■	■
Metal Working						■	■	■	■	■	■
Halogenated Olefins				■	■	■	■	■	■	■	■
Alkyl Silanes		■	■	■	■	■	■	■	■	■	■
Metal Alkyls	■	■	■	■	■	■	■	■	■	■	■


Because we care deeply about the quality and consistency of our products, no detail is overlooked. Chevron is passionate about satisfying customer needs and our technical support is world-renowned.

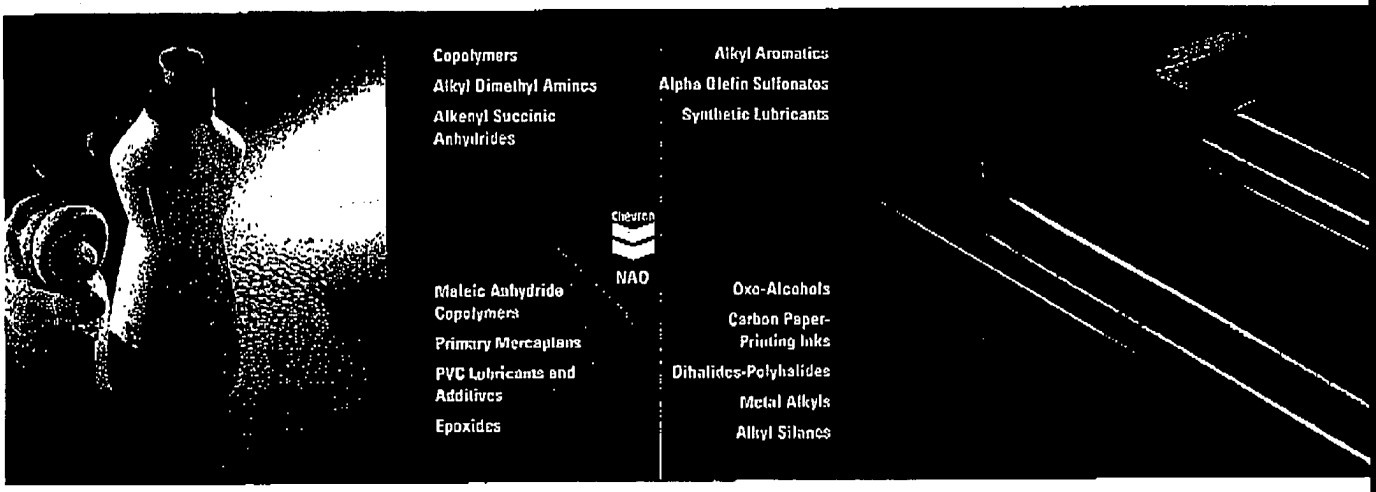
POLYMERS

Homopolymers and Copolymers Other Than Polyethylene

Certain Gulftene alpha olefins can be used to prepare homopolymers and copolymers other than polyethylene. Gulftene 4 can be polymerized to 1-polybutene (PB), a homopolymer that is ideal for many engineering applications because of its excellent long-term mechanical properties.

PB is extremely creep resistant and behaves similarly to a crosslinked plastic. It features a unique combination of unusually high tensile strength and good tear properties. PB shows no signs of cracking, crazing or fracturing when stressed below its short-time failure stress value for long periods of time. In addition, its tear strength increases rapidly as the tear rate escalates. PB's benefits broaden the commercial applications for polymers.

Gulftenes 6, 8, 10, 16, 18, 20-24 and 24-28 are used for the production of copolymers. Using peresters as initiators, copolymers of maleic anhydride and alpha olefins can be formed.



ur extensive line of ulftene alpha olefins is sed in many commercial pplications, including olymers, synthetic fluids, urfactants, additives and pecialty chemicals.

The maleic copolymer made from Gulftene 18 is a Chevron product known as PA-18, which has been used successfully as a release agent in tapes and paper templates for PVC curtains, and in water-resistant sunscreen formulas.

The copolymers produced from other Gulftene alpha olefin fractions are normally converted to acid amides, half esters or diesters for use as lube-oil additives and pour-point depressants. They are also effective curing agents for epoxy resins and act as unique thermoset resin compositions in liquid monoepoxides. In addition, Gulftenes 6, 8 and 10 have been co- and terpolymerized with vinyl acetate and vinyl chloride.

Polyethylene Copolymers

Chevron Gulftenes 4, 6 and 8 have become increasingly important as comonomers with ethylene for the production of high strength and high stress-crack resistant, high-density polyethylene (HDPE) resins.

HDPE is principally used for the manufacture of household and industrial chemical bottles, oil bottles, food containers, grocery sacks, merchandise bags and pipe.

High-density polyethylene possesses high flex stiffness (flexural modulus) but low environmental stress cracking resistance (ESCR). Lowering the melt index (high melt viscosity) can help to alleviate the low ESCR, but the processibility of the polymer suffers due to lower flow rates. The addition of Chevron Gulftene 4, 6 or 8 as a comonomer increases the melt index, thereby improving the flow properties and greatly increasing the ESCR.

In addition, HDPE polymers made with Gulftene 6 as a comonomer have much higher ESCR than those made with 1-butene. For a given polymerization process, at a polymer density of 0.950 g/cc and melt index ranges of 0.2 to 0.3 g/10 minutes, 1-butene copolymers had ESCR values of 50 to 310 hours and 1-hexene copolymers exhibited ESCR values of 800 to more than 1,000 hours. Copolymerizing with Gulftene 8 rather than 1-hexene produces polymers with even better ESCR values.

Similarly, linear low-density polyethylene (LLDPE) produced with Chevron alpha olefins is strong and has excellent stress crack resistance, making it ideal for many film applications, as well as for the production of overcaps or lids for food containers.

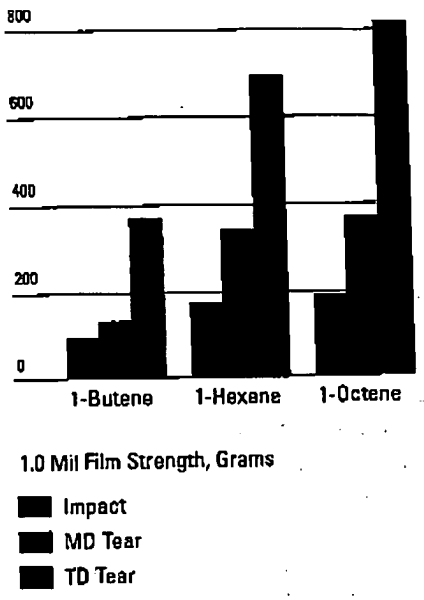
In the past, only high-pressure or conventional low-density polyethylenes (LDPEs) were used for applications requiring flexibility. However, many of these applications now utilize linear low-density polyethylene.

LLDPE is made by incorporating a higher level of comonomer, either 1-butene, 1-hexene or 1-octene, to reduce the density of linear polyethylene relative to HDPE. Yet, LLDPE provides significantly greater stiffness and much higher ESCR values than LDPE. Because the melt index of the LLDPE can be raised to values much higher than that of LDPE (while maintaining equivalent or superior physical properties), processing cycle times can be reduced. In addition, if processing times are satisfactory, products made with LLDPE can be downgauged to save on raw material costs.

Because of its outstanding strength and tear resistance, linear low-density polyethylene is used in virtually all film applications. Film made entirely from LLDPE or from blends of LLDPE and LDPE is far stronger than that made only from LDPE. The type of comonomer used in manufacturing LLDPE affects the material's strength. Film made from LLDPE using Gulftene 8 is stronger and more tear resistant than that made with Gulftene 4 as the comonomer.

For the greatest possible strength and tear resistance, the density can be reduced below that of LLDPE and LDPE through copolymerization with lower alpha olefins to produce very low-density polyethylene (VLDPE). VLDPE has a higher heat-seal temperature than LDPE, yet provides equivalent seal strength.

Effects of Comonomer on Film Properties



SURFACTANTS

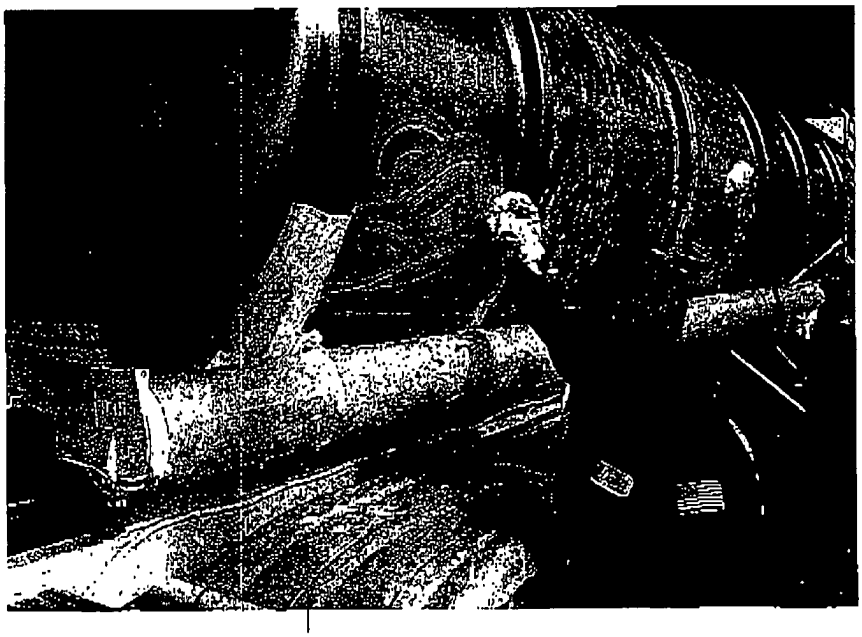
Alpha Olefin Sulfonate (AOS)

Gulftenes are excellent intermediates for producing alpha olefin sulfonate (AOS) surfactants. These surfactants provide outstanding detergency, high compatibility with hard water, and good wetting and foaming properties. AOS is free of skin irritants and sensitizers, and it biodegrades rapidly. It is used in high-quality shampoos, light-duty liquid detergents, bubble baths, and heavy-duty liquid and powder detergents. It is also used in emulsion polymerization. C_{14-16} AOS blends are frequently used in liquid hand soaps.

To make AOS, alpha olefins are first sulfonated in a continuous thin film reactor to produce a mixture of alkene sulfonic acids and sultones (cyclic sulfonate esters). The mixture is neutralized with aqueous sodium hydroxide, then hydrolyzed at elevated temperatures to convert the remaining sultones to alkene sulfonates and hydroxy sulfonates. This results in an aqueous solution of alpha olefin sulfonate. (If a solid, anhydrous product is desired, it can be easily obtained by neutralizing and hydrolyzing the solution in isopropanol instead of water.)

Detergent Alcohols

Gulftenes are easily converted to primary alcohols via oxo chemistry. By reaction with ethylene oxide, the alcohols form a variety of nonionic ethoxylates, which may themselves serve as surfactants or be further derivatized. Anionic alkyl ether sulfates can be derived from the sulfation of the ethoxylates. These are widely used in the cosmetics and toiletries industries. Alternatively, the alcohols may be directly sulfated to produce alkyl sulfates.



Linear Alkyl Benzene Sulfonates

Gulftenes react with benzene via Lewis acid catalysis to form linear alkyl benzenes (LABs). Sulfonation and subsequent neutralization of LAB result in linear alkyl benzene sulfonates, which are commonly used in dish-washing liquids, laundry detergents, all-purpose cleaners and lube-oil additives. Similarly, phenol or naphthalene will react with olefins, producing other types of detergents and wetting agents upon sulfonation/neutralization.

Amine Derivatives

Gulftenes are also suitable for manufacturing alkyl dimethyl amines (ADMAs), which are precursors to a number of surface-active derivatives. Amine oxides produced via hydrogen peroxide oxidation of ADMAs are excellent foam boosters and are typically used in shampoos, bubble baths and dishwashing detergents.

Quaternary ammonium halides or "Quats," which result from reaction of ADMAs with alkyl or benzyl halides, are highly effective biocides and anti-static agents. Betaines, which are mild, amphoteric surfactants, feature good foam boosting and stabilizing properties. They are readily derived from ADMAs by reaction with sodium chloroacetate.

Alkane Sulfonates

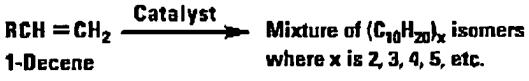
Sodium bisulfite will react with Gulftenes via a free-radical mechanism to produce alkane sulfonates. Alkane sulfonates with chain lengths of C_{12} or higher have limited water solubility, suggesting their application in synthetic detergent bars. Shorter alkane sulfonates like C_8, however, are hydrotropic.

SYNTHETIC FLUIDS

Polyalphaolefins

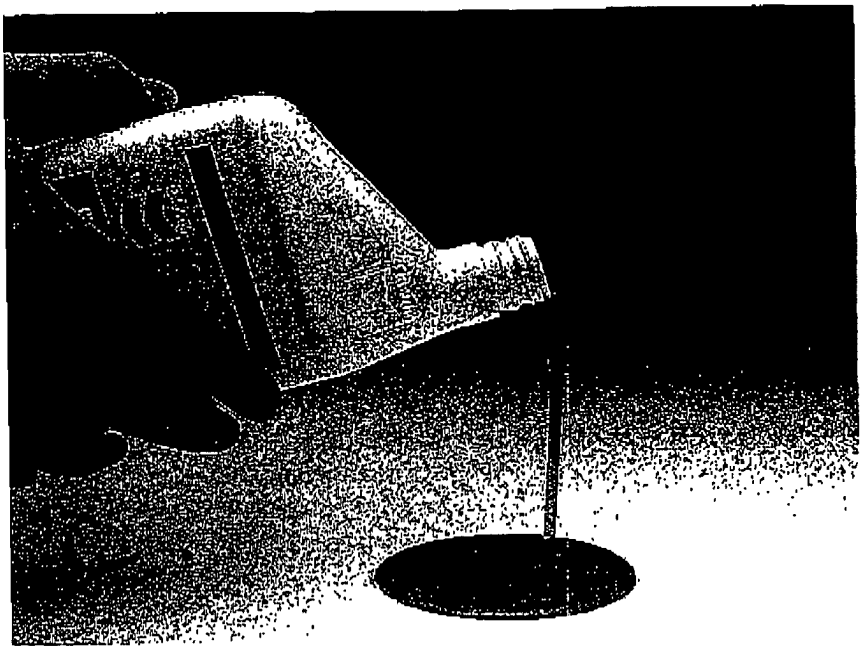
Synthetic base fluids for high-performance lubricants and functional fluids can be prepared by oligomerizing Gulftene alpha olefins, particularly Gulftene 10. The resulting oligomers, consisting of dimers, trimers, tetramers and so on, are typically hydrogenated and then formulated with appropriate additives.

Polyalphaolefin (PAO) fluids such as Chevron's Synfluid® PAO are miscible with mineral oils and most other synthetic base fluids, and are compatible with most commonly used coatings, plastics, elastomers and other conventional materials. Their excellent low temperature properties, high viscosity index and low volatility result in superior automotive, industrial and aerospace lubricants offering greater efficiencies, longer service life and improved economics relative to mineral oil.



PAO AND MINERAL OIL COMPARISON	PAO4	100N Oil*	PAO6	200N Oil*
Viscosity, cSt @ 100°C	3.9		5.9	
Viscosity, cSt @ 40°C	16.9		30.5	
Viscosity, cSt @ -40°C	2420	5000	7500	10
Viscosity Index	127	95	135	100
Pour Point, °C	-73	-12	-68	-15
Noack Volatility, Wt.%	13	20	6	9

*Solvent Refined Mineral Base Oil



Polyol Esters

Gulftene alpha olefins yield odd-numbered acids upon hydroformylation followed by oxidation. Polyol esters are then prepared by reacting the acids with polyols such as pentaerythritol. A key feature of these esters is their outstanding tolerance of a wide range of temperatures. This is one reason that they are used as the base fluids for jet engine lubricants and refrigeration compressor oils for the new HFC-134a chlorine-free refrigerants.

$$\underset{\text{1-Hexene}}{RCH=CH_2} + H_2 + CO \xrightarrow{\text{Catalyst}} \underset{\text{Heptaldehyde}}{RCH_2CH_2CHO} \xrightarrow{\text{Ox}} \underset{\text{Heptanoic Acid}}{RCH_2CH_2COOH}$$

$$\underset{\text{Heptanoic Acid}}{4\ RCH_2CH_2COOH} + \underset{\text{Pentaerythritol}}{HOCH_2-\overset{\overset{CH_2OH}{|}}{\underset{\underset{CH_2OH}{|}}{C}}-CH_2OH} \longrightarrow \underset{\text{Pentaerythritol Tetraester}}{C(CH_2O\overset{\overset{O}{\|}}{C}R')_4} + 4\ H_2O$$

Alkyl Aromatics

Phenol or benzene can be alkylated with Gulftene alpha olefins to produce phenates or dialkyl benzenes. Phenates (alkyl phenol salts) are

ADDITIVES

Plasticizer Alcohols

C_8 through C_{10} alpha olefins are used to produce primary C_9 through C_{11} plasticizer alcohols via hydroformylation or oxo chemistries. The phthalate plasticizers produced from these alcohols gave superior properties to those made from 2-ethyl 1-hexanol. The same chemistry is used to produce C_{13} to C_{15} synthetic detergent alcohols from C_{12} and C_{14} alpha olefins.

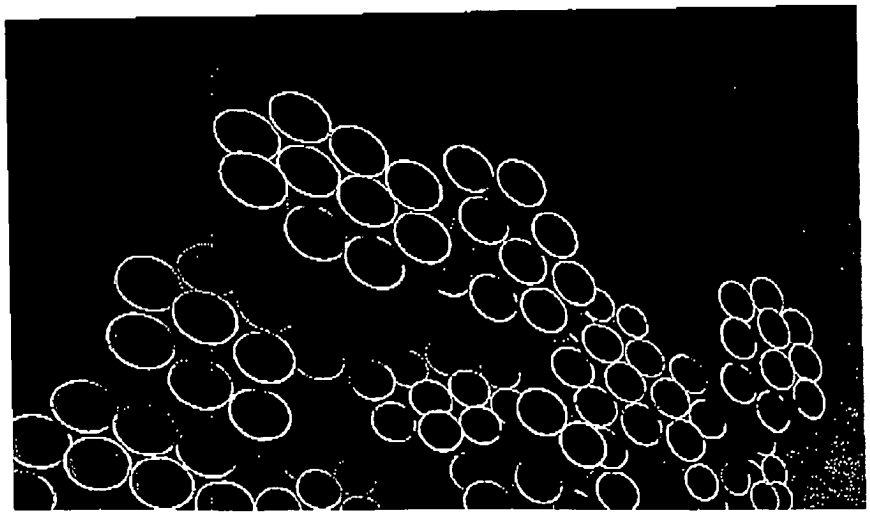
Alkenyl Succinic Anhydrides

Alkenyl succinic anhydrides (ASAs) are prepared by heating alpha olefins and maleic anhydride to approximately 200°C. Some ASAs are used as dispersants in lube oils and automatic transmission fluids, and as pour-point depressants in lube and crude oils. Others are converted to acid amides, half esters and diesters. One of the largest applications for ASA is as the paper sizing agent in alkaline media. For this use, Gulftenes 16 or 18 are isomerized to a thermodynamic distribution of internal olefins, which are then reacted with maleic anhydride to produce the desired liquid ASA.

Polyvinylchloride Lubricants and Stabilizers

Heat and pressure are applied during the extrusion of polyvinylchloride (PVC) as it moves through the die. Lubricants (waxes) are compounded into the PVC to ensure proper lubrication in the extruder and to control fusion of the PVC compound. Gulftene 30+ is the preferred lubricant for this application.

During the extrusion process, PVC often begins to decompose. Various materials are used to retard this degradation, including dibutyl or dioctyl tin oxides, and/or dioctyl tin mercaptides. These compounds are made using tin (IV) chloride and the corresponding aluminum alkyls, which in turn are derived from alpha olefins. The mercaptans used to make the tin mercaptides are usually made from alpha olefins.



SPECIALTY CHEMICALS

Epoxides

Treatment of alpha olefins with peracids forms epoxides, which find use as modifiers for epoxy resins. Epoxides may also serve as polyether ingredients in polyurethanes. Almost all carbon number fractions of Chevron alpha olefins find some application in the epoxide market.

Halogenated Alpha Olefins

Chlorinated Gulftene 20-24 (C_{20-24} alpha olefin) is appropriate for use as a secondary plasticizer in PVC formulations. This 40% chlorinated alpha olefin derivative was evaluated in comparison with Imperial Chemical Industries (ICI) Cereclor 42 (42% chlorinated paraffin) and Conoco H-35 (alkyl-aryl hydrocarbon). The evaluation of the mechanical properties of these formulations shows that the chlorinated Gulftene alpha olefin blend is equivalent in plasticizing efficiency to the two other secondary plasticizers, providing adequate heat stability and volatility properties. It, as well as polychlorinated C_{12}, C_{14} and C_{16}, also performs well as a stable, high-pressure additive in metalworking fluids.

Additional Applications

Gulftene alpha olefins can be used in many other applications, including the production of mercaptans, ketones, esters, pyrazines and other compounds, and as substitutes for paraffin and other waxes.

When hydrogen sulfide is added to alpha olefins under the proper conditions, mercaptans are formed. These mercaptans have been used successfully in rubber additives, ore flotation and specialty chemicals applications.

Alpha olefins may be converted to internal olefins of higher chain lengths by metathesis or disproportionation and dimerization reactions.

Trialkylphosphines and trialkylphosphine oxides, silylhydrocarbons, alkyl silanes and some organometallic compounds are produced commercially from alpha olefins for a wide variety of end products.

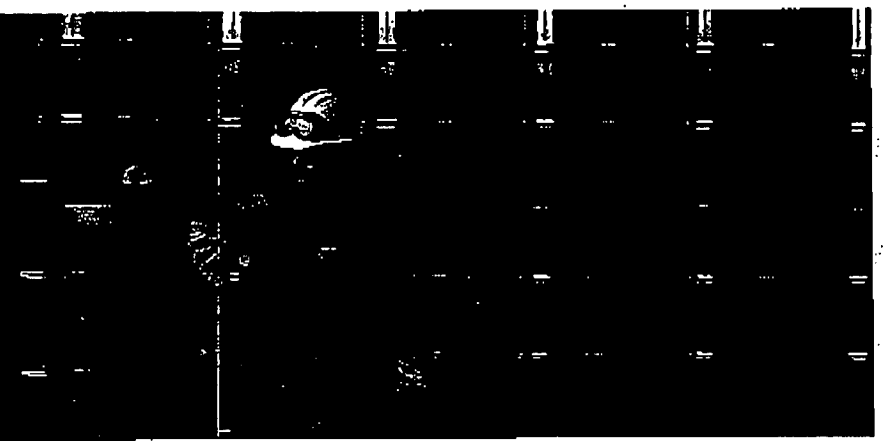
Derivatives of Gulftene alpha olefins above C_{20} find uses in lube oils, transmission fluids, and as pour-point depressants in lube and crude oil. These wax fractions may also be chemically modified to simulate more expensive carnauba or Montan waxes used to make polishes and candles.

SHIPPING AND HANDLING

Efficient and Reliable Transportation

Chevron Chemical maintains an extensive distribution system to ensure that our products will get to you on the date that we have committed. Our Gulftene alpha olefins are transported in bulk shipments via tank cars or tank trucks. Gulftenes 6 through 30+, with the exception of custom blends, are also available in 55-gallon, steel, epoxy-lined, nonreturnable drums and five-gallon pails. Sample quantities are typically shipped in one gallon cans.

Long before ISO certification became the earmark of quality-commitment, Chevron Chemical adopted the Deming Philosophy, which we have applied to every aspect of our business.



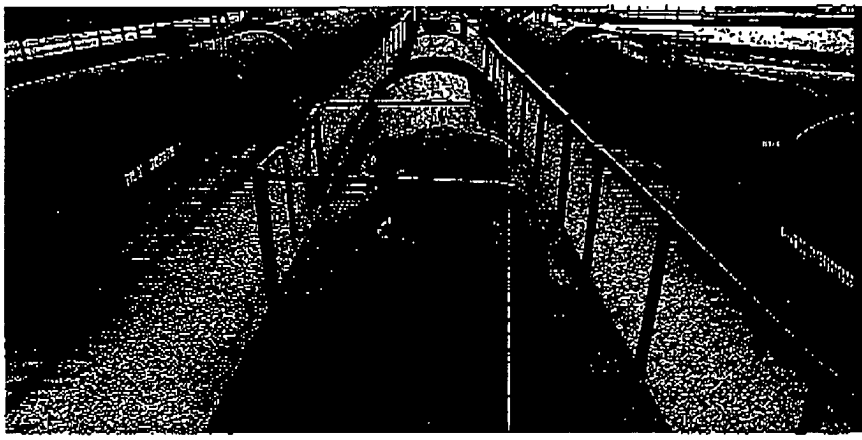
European customers have the option of 1.0- and 1.1-cubic meter totes. Customized blends of two or more fractions, accurate to ± 2 wt%, are available in tank truck or tank car quantities. Inhibitors to help prevent the formation of peroxides can be added to any of our Gulftene alpha olefins upon request.

Export shipments in containers and isotanks are made from the Cedar Bayou plant. Products shipped by marine barge and vessel are loaded out of Stolthaven Terminal facilities located on the Houston Ship Channel. These facilities were specially designed and constructed with miles of dedicated piping to prevent contamination.

Utilizing our fleet of tank trucks helps us deliver our products to you on time with no shipping delays.

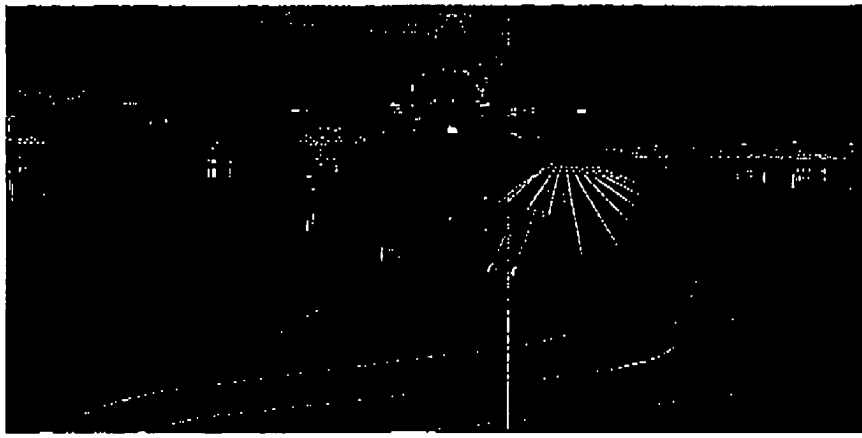
Responsible Handling

Although Gulftene alpha olefins pose little environmental, health and safety risks, Chevron is committed to the Responsible Care® initiative and to safely providing a quality product. This is demonstrated by the considerable efforts made to ensure the integrity and purity of every shipment, and the precautions we take to protect people and the environment from accidental releases.



We provide our customers and other handlers with the information they need to safely transport, store, use and dispose of our products.

Gulftene alpha olefins are stored under nitrogen blankets. To prevent the formation of peroxides and minimize the escape of vapors, our storage tanks and loading facilities for the lower fractions, located at Cedar Bayou, the Stolthaven Terminal and the Antwerp Terminal, feature totally closed systems.



Chevron storage and loading facilities are specially designed as totally closed systems to minimize accidental release of vapors into the environment.

Responsible Care is a shared responsibility. Please do your part and carefully review the most current Material Safety Data Sheet (MSDS) on any fraction before you use it.

TOXICOLOGY

The following toxicology information is based on selected Gulftene alpha olefins as well as other alpha olefins toxicity data. The fractions chosen for toxicological studies were considered representative of the product line, allowing for reasonable interpolation for blends not included.

PHYSICAL PROPERTIES	C_6	C_{10}	C_{16}	$C_{12\text{-}16}$
Physical State	[illegible]	[illegible]	[illegible]	[illegible]
Molecular Weight	[illegible]	[illegible]	[illegible]	[illegible]
Boiling Point, °F	[illegible]	[illegible]	[illegible]	[illegible]
Flash Point, TOC, °F	20	[illegible]	200	[illegible]
Vapor Pressure, mm Hg at 75°F	176	[illegible]	[illegible]	[illegible]

Toxicity

Studies have shown that Gulftene alpha olefins have little or no toxic effect on animals except in very severe inhalation conditions. Based on the high oral and dermal LD50 values, these materials are considered to be relatively nontoxic. They produce minimal skin and eye irritation, and are not skin sensitizers. Laboratory exposures to very high airborne concentrations of C_6-C_{16} alpha olefin vapors or mists produced central nervous system effects including anesthesia.

Although not all products have been tested in genetic toxicity assays, the available data indicate alpha olefins are not mutagenic.

Except for one study on one species of rainbow trout, ecotoxicity studies conducted with a wide range of products have shown little potential for toxicity to aquatic organisms.

Handling and Personal Protection

Chevron is committed to Product Stewardship and Responsible Care. We endeavor to provide sufficient information for the safe use and handling of all our products. It is important to safeguard against excessive and prolonged exposures to alpha olefin vapors and mists. Unsafe vapor concentrations may not only be harmful to workers' health, they may also constitute fire or explosion hazards.

No Threshold Limit Values® (TLVs) for these materials have been established by the American Conference of Governmental Industrial Hygienists (ACGIH).

Adequate local or general exhaust ventilation should be used to prevent the accumulation of high vapor concentrations. National Institute for Occupational Safety and Health (NIOSH)-certified organic vapor respirators or supplied air breathing apparatus should be used in the absence of reliable detection and warning devices.

Good, industrial hygiene practices should always be followed. Avoid contact of alpha olefins with eyes and skin. Splashes in the eye should be treated by thoroughly flushing with water. Contaminated skin areas should be carefully washed with soap and water, and contaminated clothing should be laundered before reuse.

If you want to improve an existing product using alpha olefins or develop a new one, put Chevron Chemical's unbeatable, global team to work for you.

Call (800) 231-3260 or (713) 754-2451 for assistance today!

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GULFTENE® 4
1-BUTENE

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_4 min.	GLC	99.8
n-Alpha Olefin, wt. % min.	GLC	99.0
cis and trans 2-Butene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	DuPont 5200	10
Oxygen, ppm by wt., max.	ASTM D 2504	5
Carbon Monoxide, ppm by wt., max.	ASTM D 2504-1	2
Carbon Dioxide, ppm by wt., max.	ASTM D 2504-1	2
Chloride, ppm by wt., max.	ASTM D 4929	1
Sulfur, ppm by wt., max.	ASTM D 3120	1

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.602
Density, lb./gal., 60°F		5.01

GULFTENE® 6
1-HEXENE

Chevron
Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_6 min.	GLC	99.0
n-Alpha Olefin, wt. % min.	GLC	98.2
Vinylidene, wt. % max.	GLC	1.3
cis and trans 2-Hexene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	25
Carbonyls, ppm by wt., max.	ASTM E 411	2.0
Peroxide, ppm by wt., max.	SM 80-17	1.0
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	77.4
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.677
Density, lb./gal., 60°F		5.64
Flash Point, TCC, °F (°C)	ASTM D 56	20.0 (-6.67)
Autoignition Temp., °F (°C)	ASTM E 659	500 (260)

GULFTENE® 8
1-OCTENE

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_8 min.	GLC	99.0
n-Alpha Olefin, wt. % min.	GLC	97.0
Vinylidene, wt. % max.	GLC	2.2
cis and trans 2-Octene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	50
Carbonyls, ppm by wt., max.	ASTM E 411	2
Peroxide, ppm by wt., max.	SM 80-17	1.0
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	65.2
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.719
Density, lb./gal., 60°F		6.00
Flash Point, TCC, °F (°C)	ASTM D 56	55 (12.8)
Autoignition Temp., °F (°C)	ASTM E 659	430 (211)

GULFTENE® 10
1-DECENE

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_{10} min.	GLC	98.5
n-Alpha Olefin, wt. % min.	GLC	95.8
Vinylidene, wt. % max.	GLC	3.6
cis & trans 2-Decene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	100
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	58.5
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.745
Density, lb./gal., 60°F		6.21
Flash Point, TCC, °F (°C)	ASTM D 56	120 (48.9)
Autoignition Temp., °F (°C)	ASTM E 659	410 (210)

GULFTENE® 12
1-DODECENE

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_{12} min.	GLC	98.0
n-Alpha Olefin, wt. % min.	GLC	94.6
Vinylidene, wt. % max.	GLC	4.2
cis and trans 2-Dodecene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	100
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	54.1
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.762
Density, lb./gal., 60°F		6.36
Pour Point, °F (°C)	ASTM D 97	-33 (-36.1)
Freezing Point, °F (°C)	ASTM D 1015	-31 (-35.0)
Flash Point, TCC, °F (°C)	ASTM D 56	171 (77.2)
Autoignition Temp., °F (°C)	ASTM E 659	399 (204)

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GULFTENE® 14
1-TETRADECENE

Chevron
Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_{14} min.	GLC	98.0
n-Alpha Olefin, wt. % min.	GLC	93.4
Vinylidene, wt. % max.	GLC	5.4
cis & trans 2-Tetradecene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	100
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	51.0
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.775
Density, lb./gal., 60°F		6.46
Pour Point, °F (°C)	ASTM D 97	10 (-12.2)
Freezing Point, °F (°C)	ASTM D 1015	9 (-12.8)
Flash Point, PM, °F (°C)	ASTM D 93	225 (107)

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GULFTENE® 16
1-HEXADECENE

Chevron
Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_{16} min.	GLC	97.5
n-Alpha Olefin, wt. % min.	GLC	92.2
Vinylidene, wt. % max.	GLC	6.5
cis & trans 2-Hexadecene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	100
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	48.8
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.785
Density, lb./gal., 60°F		6.54
Pour Point, °F (°C)	ASTM D 97	45 (7.2)
Freezing Point, °F (°C)	ASTM D 1015	39 (3.9)
Flash Point, PM, °F (°C)	ASTM D 93	270 (132)

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GULFTENE® 18
1-OCTADECENE

Chevron
Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. % C_{18} min.	GLC	97.0
n-Alpha Olefin, wt. % min.	GLC	90.6
Vinylidene, wt. % max.	GLC	7.9
cis and trans 2-Octadecene, wt. % max.	GLC	0.3
Paraffin, wt. % max.	GLC	0.3
Water, ppm by wt., max.	ASTM E 1064	100
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	46.9
Specific Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.793
Density, lb./gal., 60°F		6.60
Pour Point, °F (°C)	ASTM D 97	65 (18.3)
Freezing Point, °F (°C)	ASTM D 1015	64 (17.8)
Flash Point, PM, °F (°C)	ASTM D 93	310 (154)

GULFTENE® 20-24 ALPHA OLEFIN FRACTION

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. %		
C_{18}, max.	GLC	3.0
C_{20}, min. - max.	GLC	45-60
C_{22}, min. - max.	GLC	30-50
C_{24}, max.	GLC	15
C_{26}, max.	GLC	1.0
Color, Saybolt	ASTM D 156	+30
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
n-Alpha Olefin, wt. %	GLC	89.3
Vinylidene, wt. %	GLC	8.0
cis and trans 2-Olefin, wt. %	GLC	0.3
Paraffin, wt. %	GLC	0.3
API Gravity 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.799
Specific Gravity (Solid) 60°F/60°F (15.6°C/15.6°C)	ASTM D 70 (Modified)	0.856
Specific Gravity (Liquid) 160°F/60°F (71°C/15.6°C)	SM 350-4	0.770
Density, lb./gal., 60°F		6.67
Melting Point, °F (°C)	ASTM D 87	96 (35.6)
Flash Point, PM, °F (°C)	ASTM D 93	362 (183)
Viscosity, 99°C (210°F)		
- Kinematic, cSt	ASTM D 445	2.1
- Saybolt, SUS	ASTM D 2161	33
Penetration, 77°F	ASTM D 1321	150
Distillation, °F (°C)	ASTM D 1160/5mm	
IBP		146 (63.3)
5%		358 (181.1)
95%		400 (204.4)
EP		410 (210.0)
Color, APHA	APHA	<5

While the information and suggestions contained herein are based upon Chevron Chemical's extensive experience, there is no warranty of any kind, express or implied, relating to them. They are offered solely for your consideration, investigation and validation. Because the products are used under varying conditions and may be reacted with various hazardous and toxic chemicals over which Chevron Chemical has no control, Chevron Chemical does not guarantee the results of usage nor assume any liability connected therewith.

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GULFTENE® 24-28 ALPHA OLEFIN FRACTION

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. %		
C_{20}, max.	GLC	1.8
C_{22}, max.	GLC	4.0
C_{24-28}, min.	GLC	76.0
C_{30+}, max.	GLC	20.0
Color, Saybolt	ASTM D 156	+25
Appearance	ASTM D 4176	Clear & Bright

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
n-Alpha Olefin, wt. %	NMR	50
Vinylidene, wt. %	NMR	40
cis and trans 2-Olefin, wt. %	NMR	10
Paraffin, wt. %	Calculated	0.8
API Gravity 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.819
Specific Gravity (Solid) 60°F/60°F (15.6°C/15.6°C)	ASTM D 70 (Modified)	0.891
Specific Gravity (Liquid) 160°F/60°F (71°C/15.6°C)	SM 350-4	0.780
Density, lb./gal., 60°F		6.83
Congealing Point, °F (°C)	ASTM D 938	126 (52.2)
Drop Melt Point, °F (°C)	ASTM D 127	154 (67.8)
Flash Point, PM, °F (°C)	ASTM D 93	425 (218)
Viscosity, 99°C (210°F)		
- Kinematic, cSt	ASTM D 445	2.5
- Saybolt, SUS	ASTM D 2161	35
Penetration, .10 mm, 77°F (25°C)	ASTM D 1321	95
Distillation, °F (°C)	ASTM D 1160/5mm	
IBP		190 (87.8)
5%		436 (224.4)
95%		582 (305.6)
EP		608 (320.0), Residue 3%

GULFTENE® 30+ ALPHA OLEFIN FRACTION

Chevron Chemical

CHARACTERISTIC	METHOD	SPECIFICATION
Carbon Number, wt. %		
C_{22} max.	GLC	1.0
C_{20-28} max.	GLC	26.0
C_{30+} min.	GLC	72.0
Color, Saybolt, min.	ASTM D 156	0
Appearance	ASTM D 4176	Clear & Bright
Drop Melt Point, °F (°C) min.	ASTM D 127	164 (73.3)
Viscosity, Kinematic, cSt, 99°C (210°F) max.	ASTM D 445	10.0

ADDITIONAL INFORMATION	METHOD	TYPICAL VALUE
n-Alpha Olefin, wt. %	NMR	55
Vinylidenes, wt. %	NMR	40
Olefins, other than n-Alpha and Vinylidenes, wt. %	NMR	5
Paraffin, wt. %	Calculated	0.6
API Gravity, 60°F/60°F (15.6°C/15.6°C)	ASTM D 287	0.836
Specific Gravity (Solid), 60°F/60°F (15.6°C/15.6°C)	ASTM D 70 (Modified)	0.919
Specific Gravity (Liquid), 185°F/60°F (85°C/15.6°C)	SM 350-4	0.790
Density, lb./gal., 60°F		6.95
Congealing Point, °F (°C)	ASTM D 938	155 (68.3)
Flash Point, PM, °F (°C)	ASTM D 93	485 (252)
Viscosity, Saybolt, SUS	ASTM D 2161	52
Penetration, .10 mm	ASTM D 1321	
@ 77°F		13
@ 100°F		24
@ 110°F		34
Distillation, °F (°C)	ASTM D 1160/5mm	
IBP		204 (95.6)
5%		461 (238.3)
95%		643 (339.4)
EP		693 (367.2)